Can Deuterium stable isotopes be used to infer geographical origins of an auxiliary hoverfly and a pest moth?

Raymond, L.[1], Menozzi, P.[2], Coulon, M.[1], Hamilton, A. J.[3], Sarthou, J. P.[1],Tsafack, N. [1], Vialatte,A.[1], Ponsard, S.[4] Ouin, A.[1].

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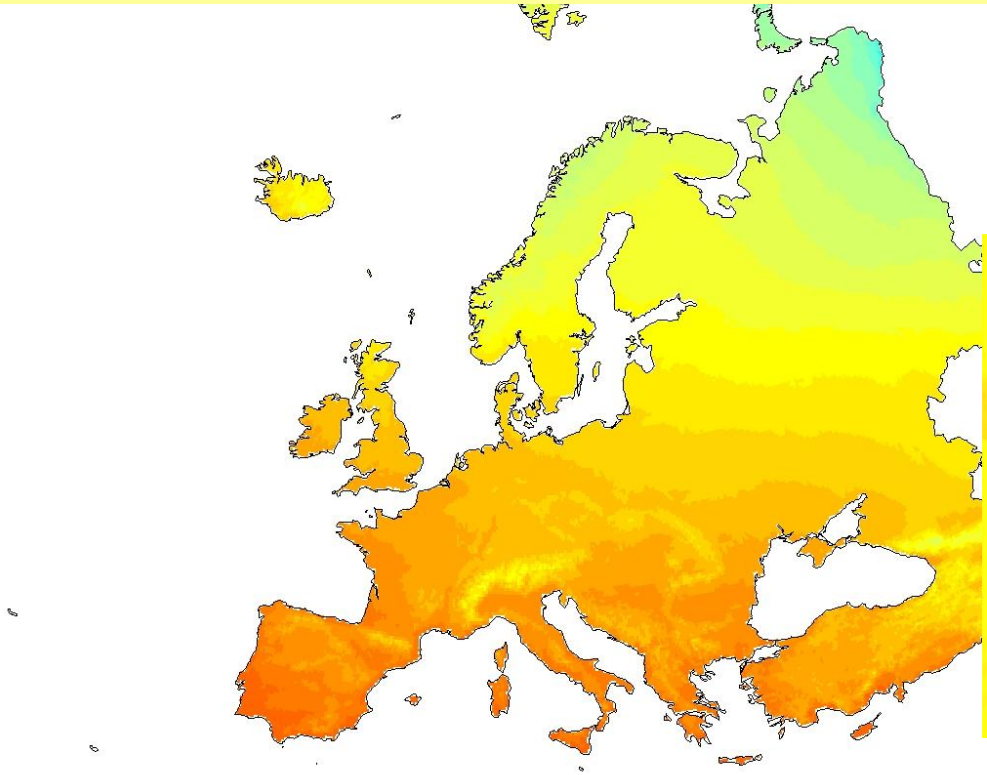


INTRODUCTION : the sooner, the better

Global aim: To feed the world with less chemicals

Need to understand the population dynamics of pest and natural enemies

Increase of the effectiveness of bio-control

One rule for the natural enemies: the sooner they are in the crop, the better is the control

What tools to study population dynamics?

1st EXPERIMENT

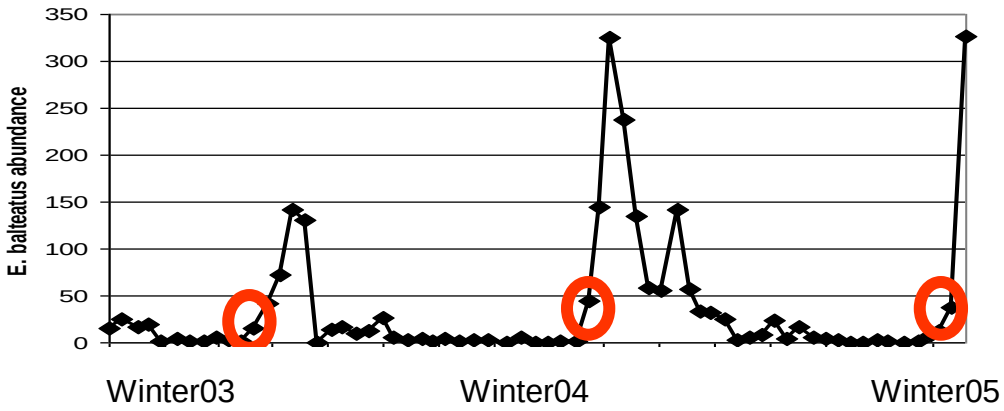
Can deuterium stable isotope be used to assign the geographic origin of an auxiliary hoverfly in South-western France?

Ouin, A., Menozzi, P., Coulon, M., Hamilton, A. J., Sarthou, J. P., Vialatte, A., Tsafack, N., Ponsard, S.

Rapid Communications in Mass Spectometry, 2011

INTRODUCTION : the sooner, the better

Where do early spring *E. balteatus* adults come from ?



E. balteatus abundance in 10 woods from winter 2003 to summer 2005 in South of France (Malaise traps)

- From local overwintering populations ?

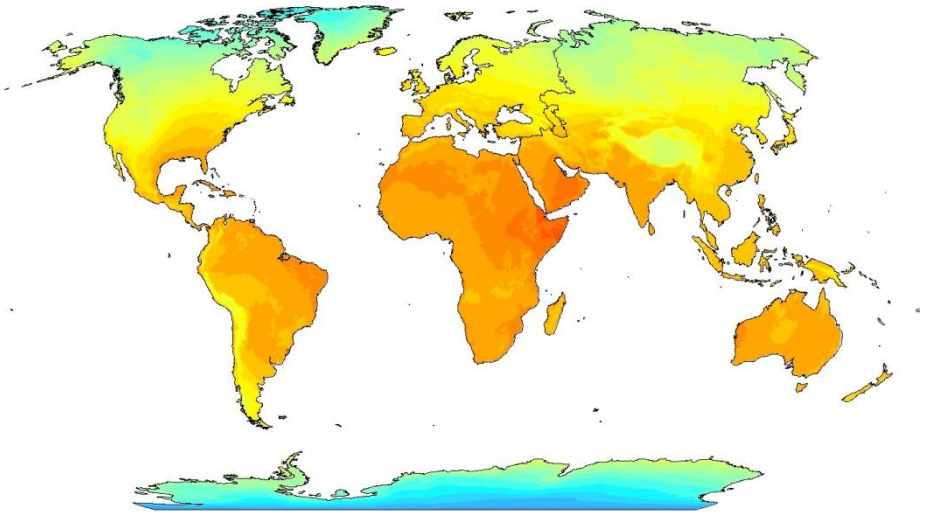
- From migratory individuals from warmer regions ?

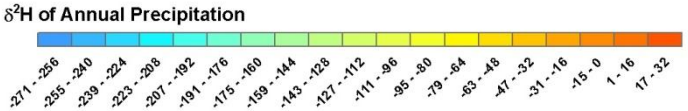
Sarthou, J.-P., Ouin, A., Arrignon, F., Barreau, G. Bouyjou, B. 2005. Landscape parameters explain the distribution and abundance of *Episyrphus balteatus* (Diptera: Syrphidae). European Journal of Entomology, 102 (3), 539-545.

INTRODUCTION : the use of Deuterium

The use of δD gradient to infer geographical origin

- A fractioning in the water F (temperature, elevation, distance to the sea)

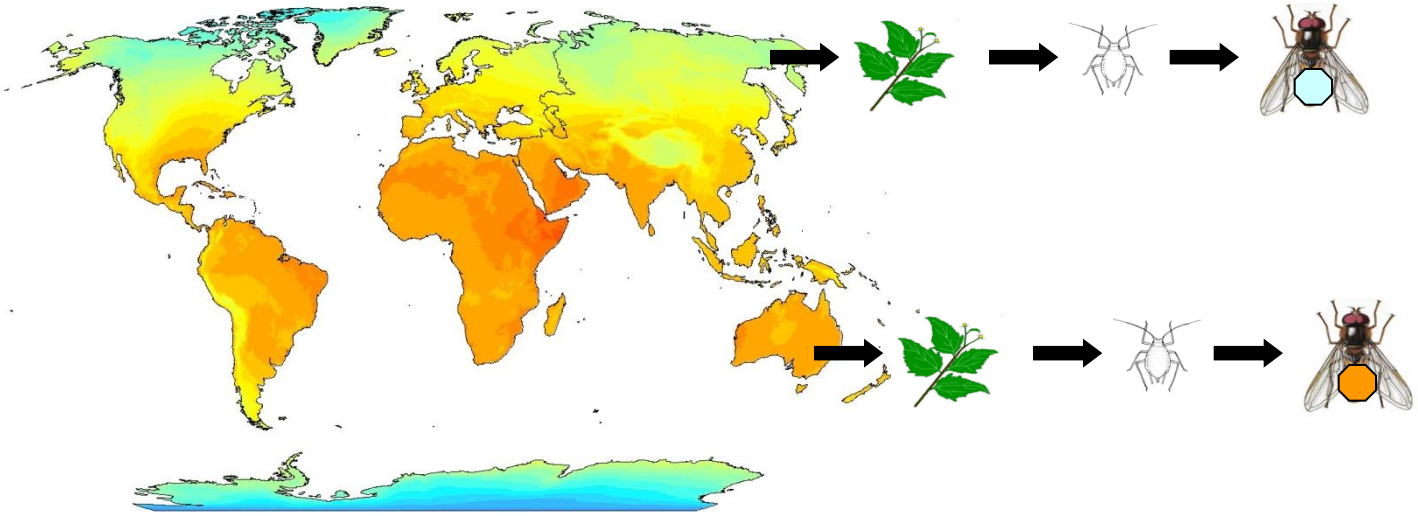


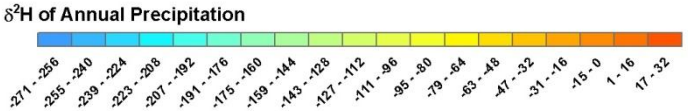


INTRODUCTION : the use of Deuterium

The use of δD gradient to infer geographical origin

- A fractioning in the insect F (trophic level, dietary preference, organic/water sources)

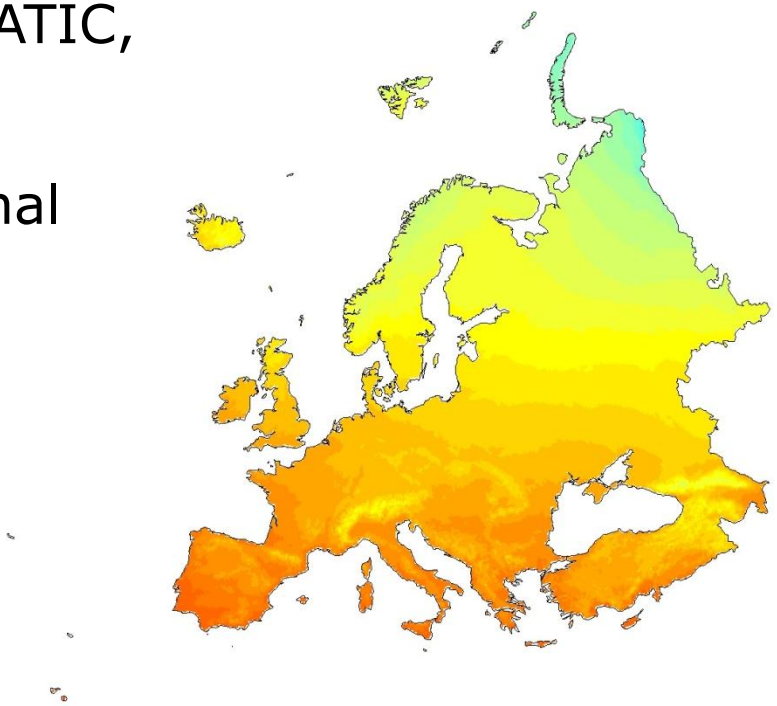




METHODS : minimum separation distance

Data: GNIP (Global Network of Isotopes in Precipitation)

- But maps like this represent STATIC, long-term (e.g. 40y) mean δD
- Inter-annual and inter-seasonnal variations of δD

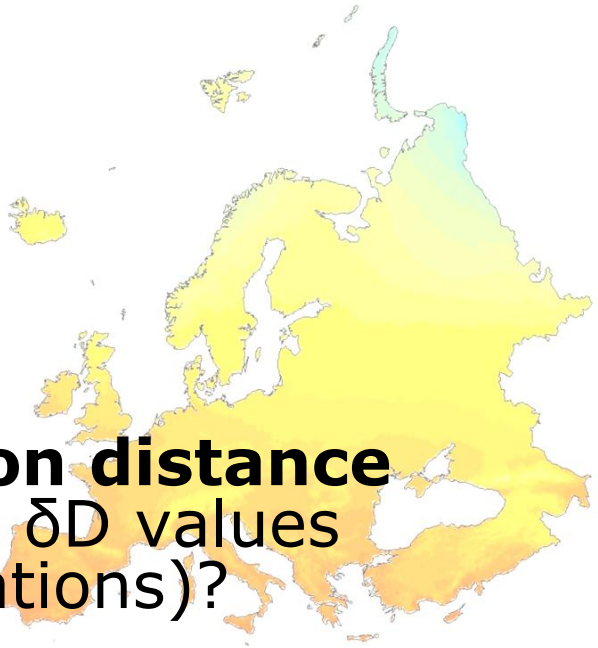


METHODS : minimum separation distance

Data: GNIP (Global Network of Isotopes in Precipitation)

➡ But maps like this represent STATIC, long-term (e.g. 40y) mean δD

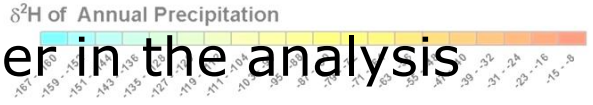
➡ Inter-annual and intra annual variation of δD



Calculation of minimum separation distance necessary to conclude that distinct δD values represent different sites (or populations)?

➡ Quantile regression approach of Farmer *et al.* (2008)

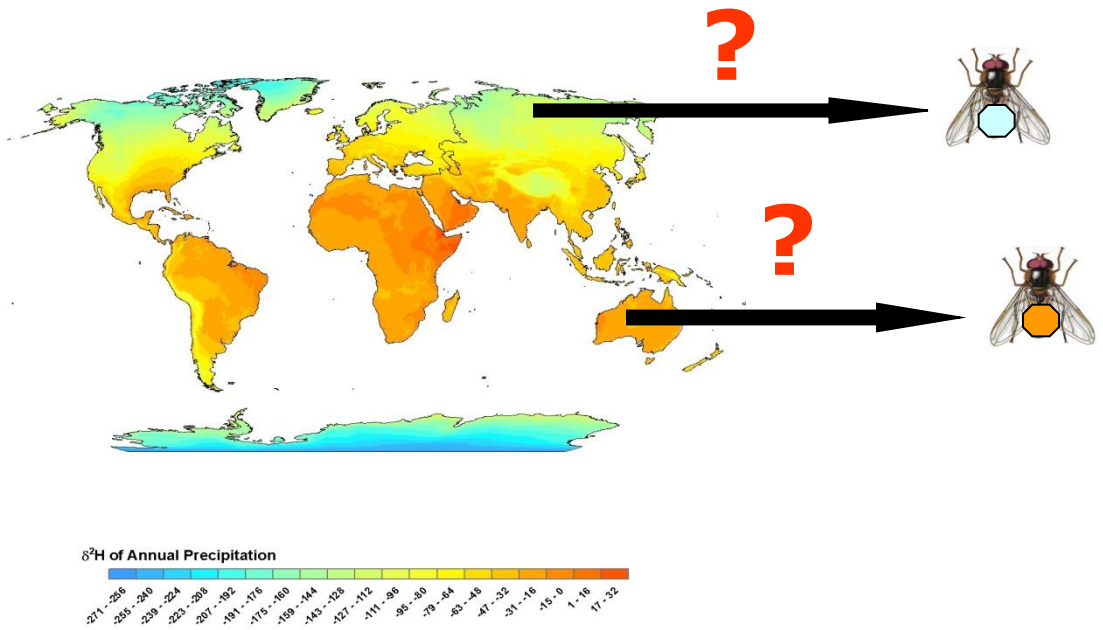
➡ Selection of periods to consider in the analysis



METHODS : autumn and spring migration

The relationships between deuterium concentration in water and in *E. balteatus.*

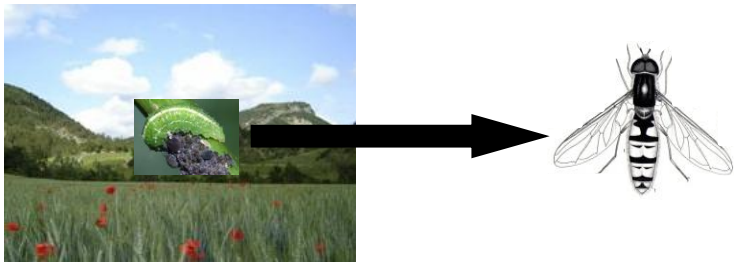
Analysis of adults reared in different labs using different waters



METHODS : autumn and spring migration

The "local signal" of wild *E.balteatus*

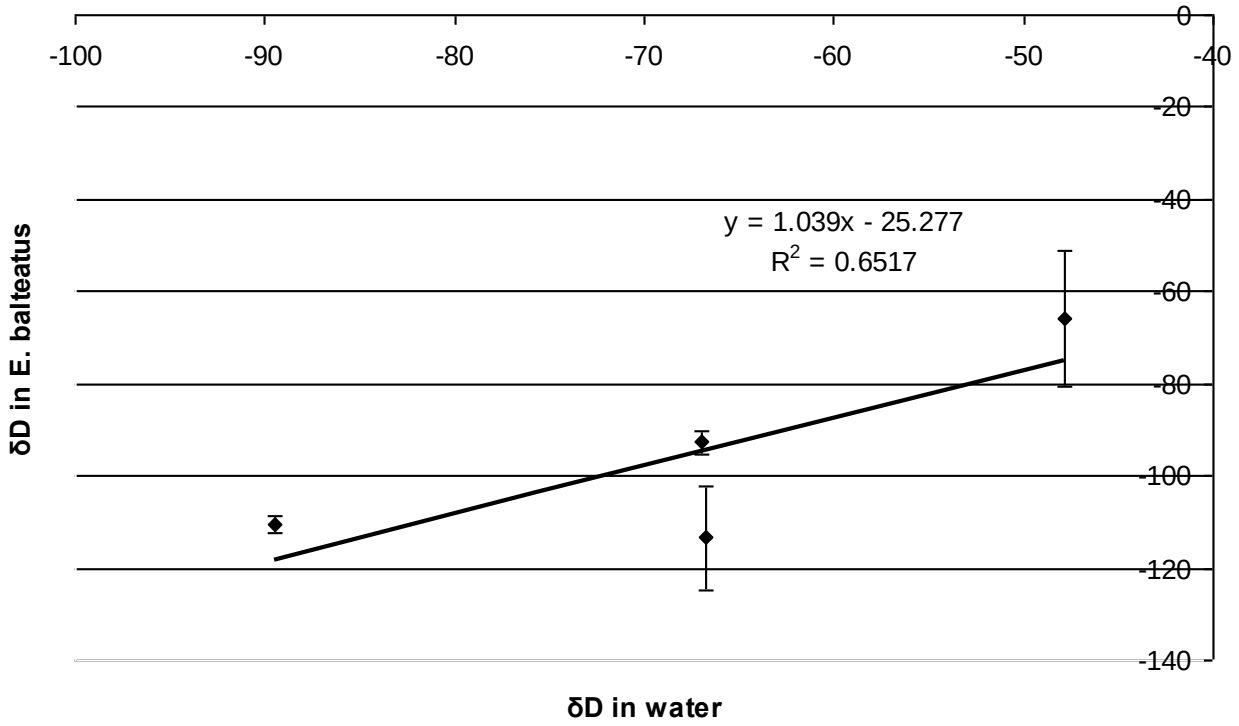
→ Trapping locally grown adult (larvae trapping)



The δD signal of wild adults in the different seasons

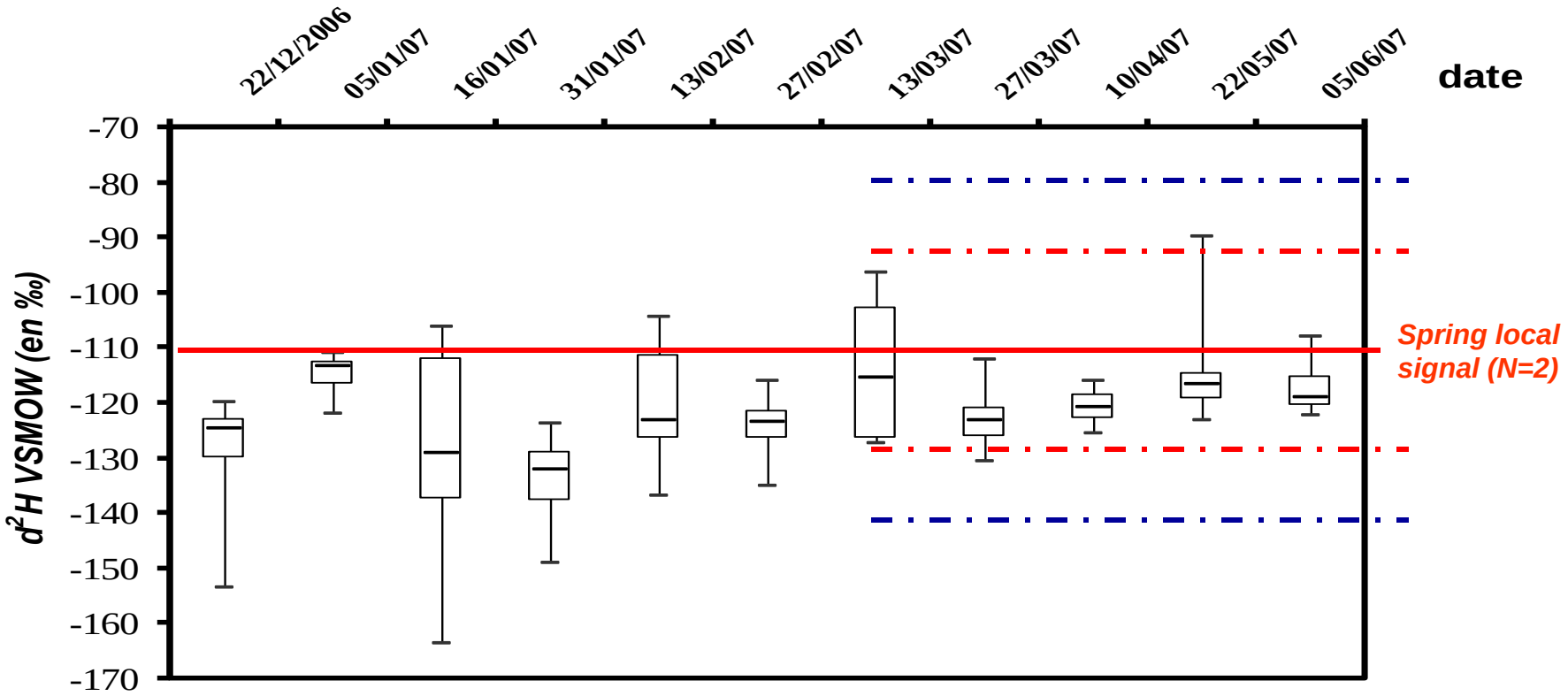
→ adult trapping

RESULTS : linear regression between water and reared hoverflies

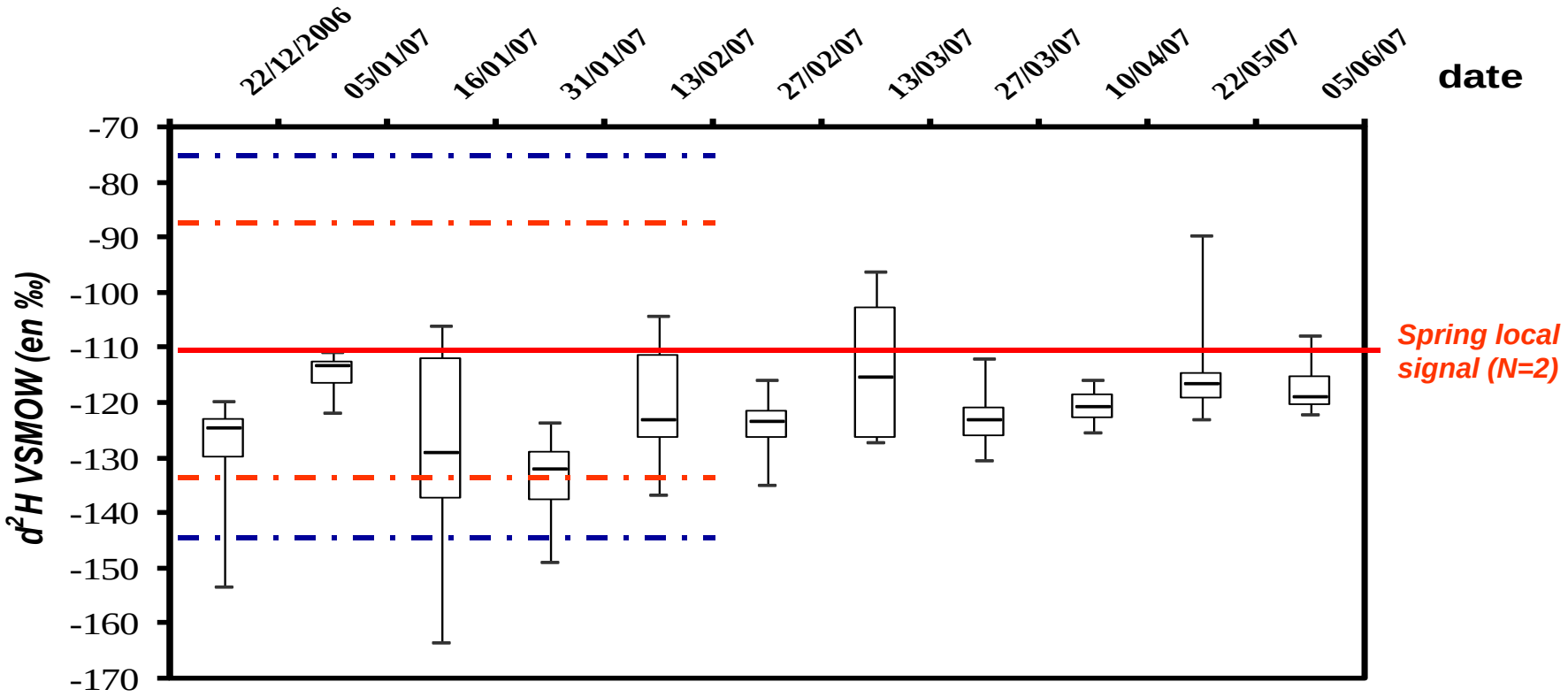


Relationship between δD values of wings and chitin pieces of laboratory-reared E. balteatus and those of the growth water used to raise the aphids. (Sample size from left to right: 2, 5,6,6.)

RESULTS : Temporal dynamics of D/H ratio in wild adult individuals in SW France



RESULTS : Temporal dynamics of D/H ratio in wild adult individuals in SW France



22.7 ‰, i. e. 12.4° Lat i. e. 1350 km for 70% separation confidence for spring - summer reared individuals (autumn adults).

31.6 ‰, i. e. 25° Lat for 90% separation confidence

CONCLUSION OF THIS STUDY

- Europe as large separation distance (high inter-annual variability of δD in precipitations)

- Migratory hoverflies could not be discriminated in spring

Deuterium could be a useful tool for the study of autumn migration (individuals outside the separation confidence)

2nd EXPERIMENT

Study of autumn migration of an aphidaphageous hoverfly by using deuterium stable isotope

PhD Lucie RAYMOND (direction Manuel Plantegenest, Aude Vialatte)

METHOD : Use of reference populations

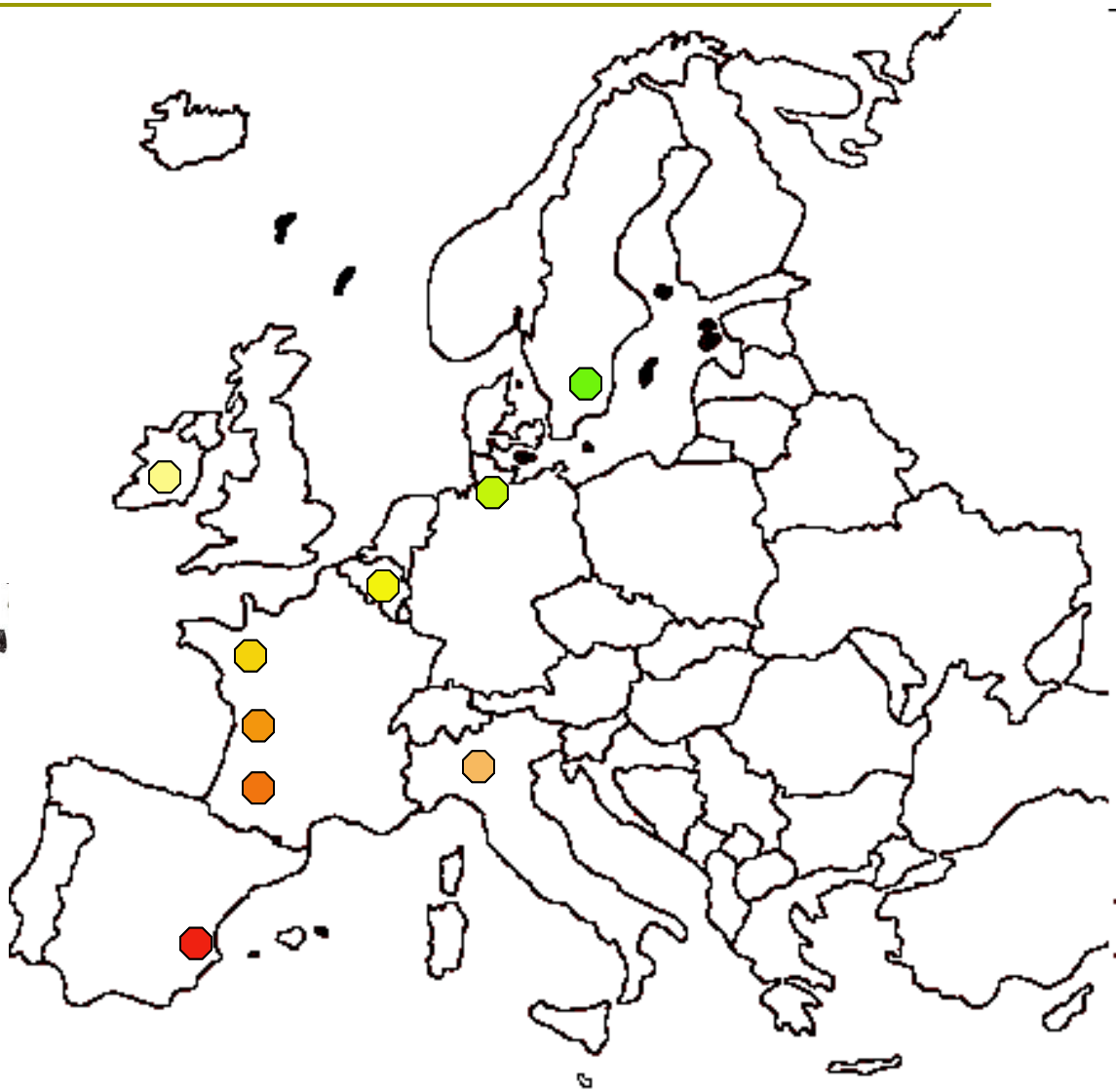
Trapping local populations in summer

METHOD : Use of reference populations

Trapping local populations in summer

Determination of the $\delta D_{\textbf{hoverfly}}$ in these populations

δD



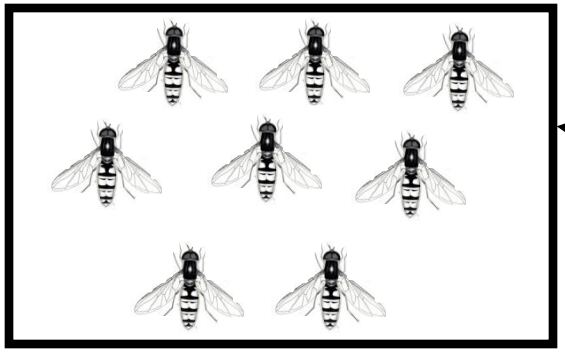
METHOD : Specific trapping of migratory hoverflies

Migration in autumn

METHOD : Specific trapping of migratory hoverflies

Migration in autumn

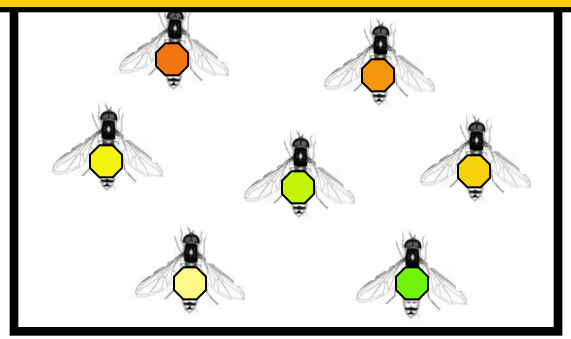
Trapping migratory hoverflies
- 3 dates
- 2 places in Pyrenees

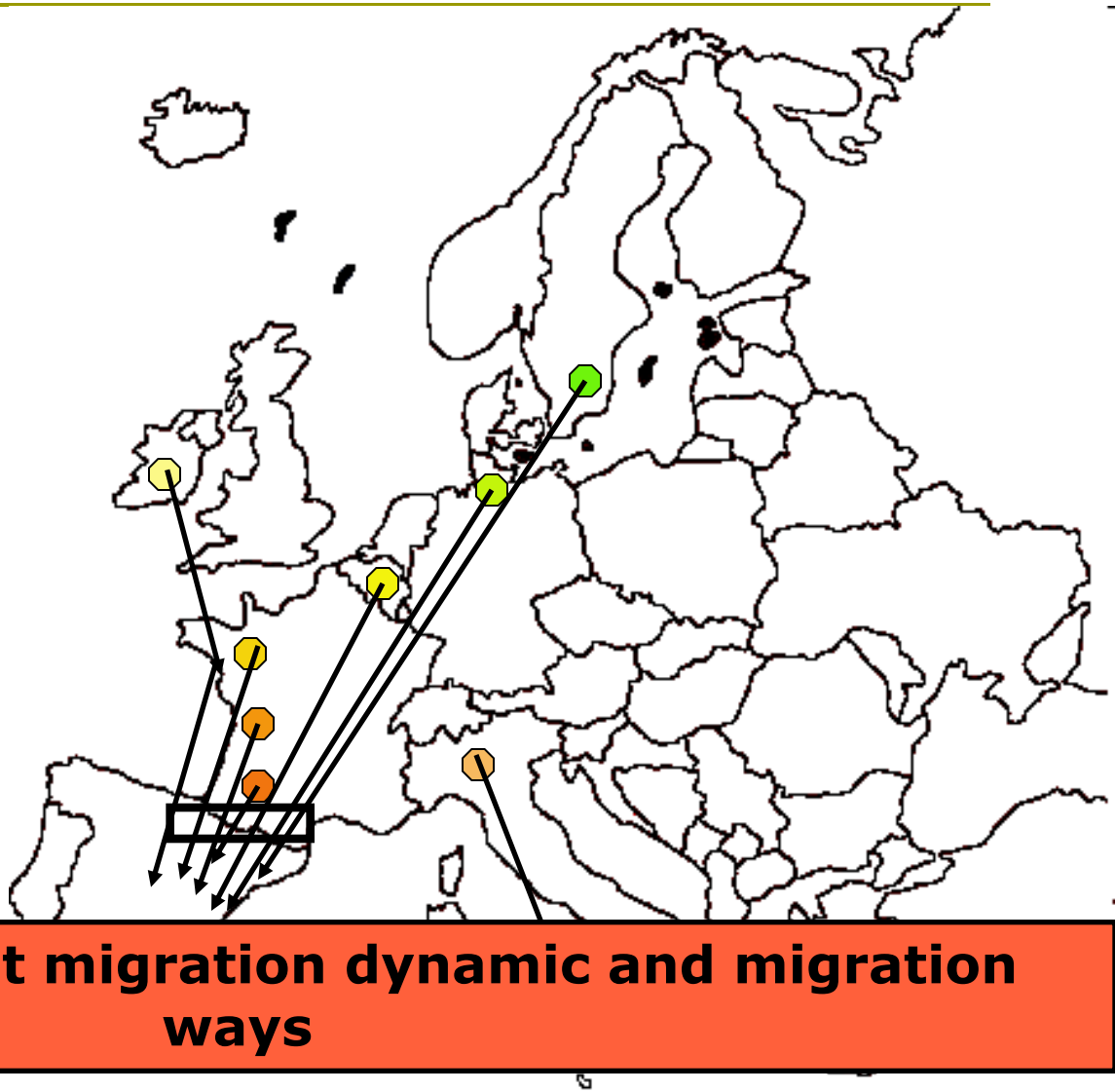


METHOD : Specific trapping of migratory hoverflies

Determination of the $\delta D_{\textbf{hoverflies}}$

Assignment of the migratory hoverflies to geographical region





Informations about migration dynamic and migration ways

PERSPECTIVES

The use of δD in tropical context “Where does H.armigera (cotton pest) come from?”

PhD Noelline TSAFACK (direction Annie Ouin, Phillippe Menozzi, Marc Deconchat)

PERSPECTIVES : the use of δD in tropical context Where does H. armigera (cotton pest) come from?

Too few data in Western Africa to use quantile regression

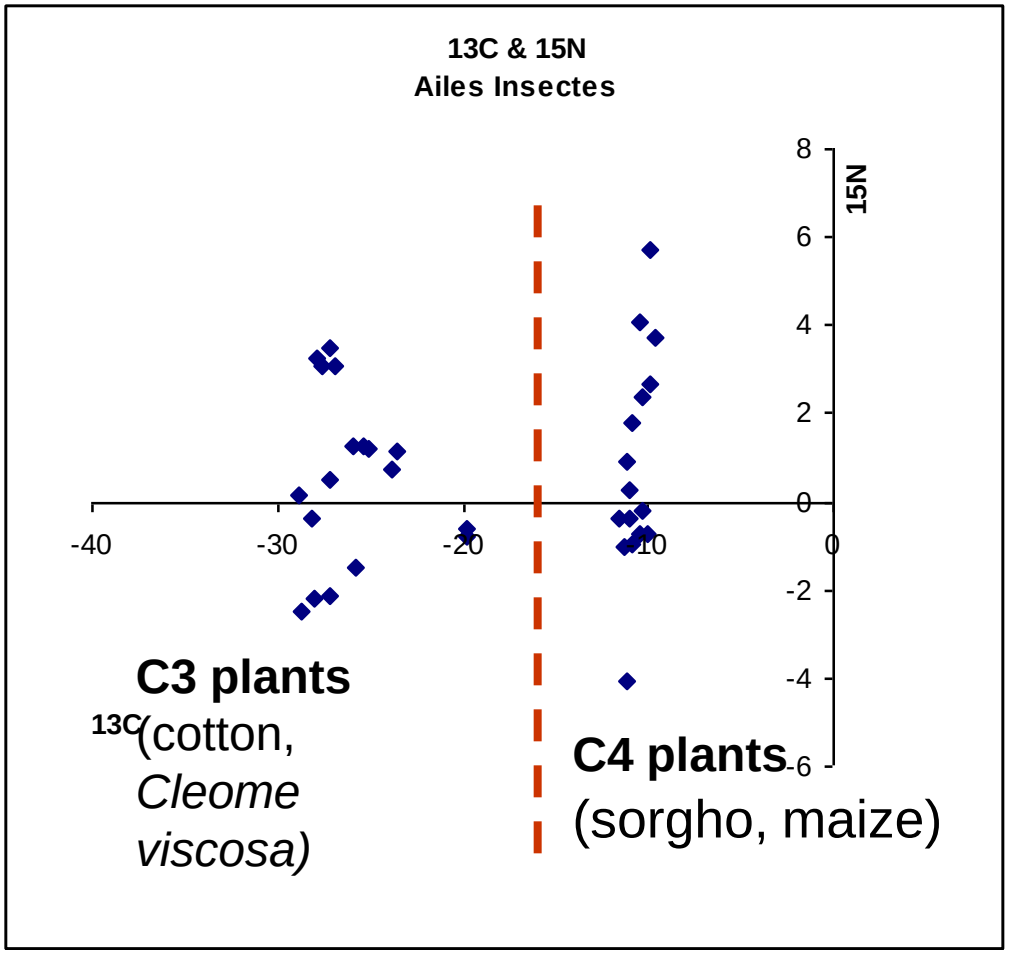
First results on δD: low variability in water *(N-S), high variability in the wing samples*

Zones in Togo	**Coordinates** (Lat, Long)	**δD in the water** (simulated in the OIPC*)	**δD in *H. armigera*** (caught Aug-Nov 2010)
North Togo	10° 49’	-19 ± 4	-84 ± 17.4
Intermediate	8° 36’	-20 ± 6	
South Togo	6° 8’	-16 ± 6	-100.5 ± 11.2

* Bowen, G. J. (Year) The Online Isotopes in Precipitation Calculator, version X.X. http://www.waterisotopes.org.

PERSPECTIVES : the use of δD in tropical context Where does H. armigera (cotton pest) come from?

Needed: agronomic calendar all over the study area



CONCLUSION GENERALE

Deuterium = interesting tool to study population dynamic of small animals

But some conditions have to be respected : enough data, enough variability beetween study zones, …

Possibilities to use other stable isotopes to infer the geographical origin

Acknowledgements

Hoverflies breeders:

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KatzBiotech, D

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Sebastian Hanke, Peter Hondelmann, Etienne Branquard, Daniele Sommaggio, Maria-Angeles Garcia, Martin Speight

Isotope advisers & analyst:

Luc Lambs, Université de Toulouse, F

IsoAnalytical, UK

R script provider:

Brian Cade, Fort Collins, USA

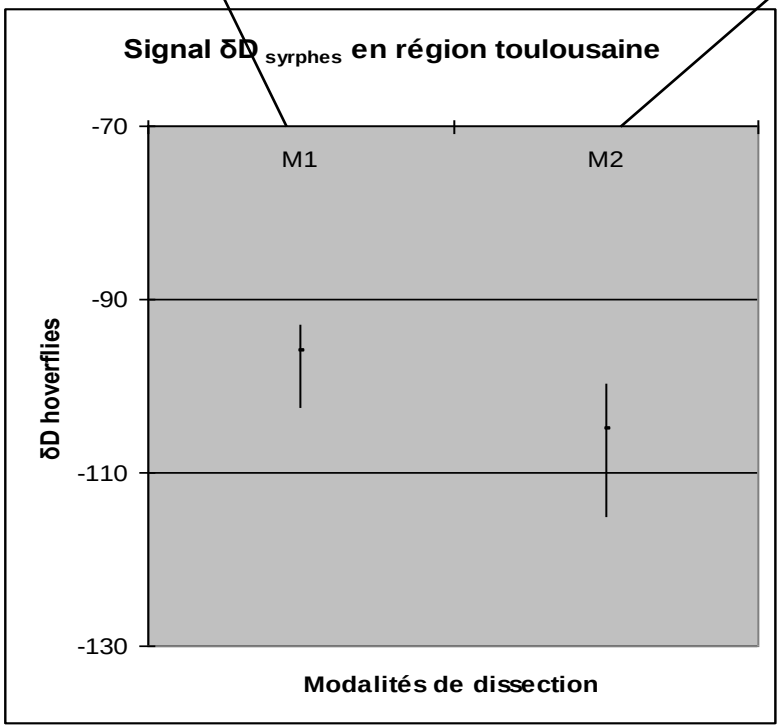
PRELIMINARY RESULTS : Local signal in the South West of France

Wings + legs

Average weight = 0.3mg/ind

Wings + legs + thorax chitin pieces

Average weight = 0.9mg/ind



- Different δD for the different tissues
- less variability if only one type of tissue
- Possibility to determine δD with only 0.3mg of tissue